QA/QC UPDATES

FOR BIOLOGISTS, ECOLOGISTS, AND WATER QUALITY SPECIALISTS

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What is New?

- Part B has Been Revised and When I get Time, I will Shorten and Streamline It.
- Some New Breakthroughs in Understanding Will Allow Me to Shorten It.
- You Don’t Need to Go Overboard.
- But “DO SOMETHING” on Checklist Item Basics (Sensitivity, Precision, Bias, etc.)

What Else is New?

- QA/QC Needed for Biology, Ecology, Habitat Measurements, and Remote Sensing.
- Why One Needs Control Measurements With QC Even if Nobody is Making You.
- More Precise Definitions of Precision
- Relationship Between Precision and Detection Limits Better Explained

WHY DO QA/QC?

- Various Groups Require It
- States, Credible Data Laws and Regulations
- DOI Information Quality Guidelines
- NPS WRD & NRRP Unified Call Funded Projects
- Regulatory Programs (RCRA, CERCLA)

But What If Nobody Is Making You Do It?

- Are There Reasons To Do It Anyway?
- Yes, For Data Interpretation
- And Making Sense (Govt. Oxymoron?)
- How Big Of A Change Is A Real Change (And Not Just Lack Of Perfect Measurement Precision?).
- Helps One Make Sense in Final Result Rounding Decisions

ENSURE FUTURE USABILITY

- Some day, some one will throw your data out if it doesn't have QA/QC documentation.
- Happening more frequently
- And this trend is not going away.
- USGS pH example at DINO
- USGS doesn't consider their own older data credible for trends.

What is Quality Assurance

- The whole system of QUALITATIVE things you do before QC to try to ensure adequate quality data: asking right questions, proper study design, DOCUMENTED protocols, SOPs, and training, etc. etc.
- Quality assurance is meant to protect against failures of quality control.

Does the one-hour average concentration (based on a minimum of 5 samples per hour collected at least three times a month for one year, or other minimum sampling specified by the State) of mercury from depth-composited water column samples at randomly chosen sites in a specified reach of river ever exceed the State water quality standard Criteria Maximum Concentration (CMC)?

Analytical Laboratories

- **N ational**
  E nvironmental
  L aboratory
  A ccreditation
  P rogram
  (NELAP) Or
  Approved by
  A Federal Agency
  After Round Robins

THE HEART OF QC

- **Control the Measurement Process!**
- **Words You Do Not Want to Hear in Court:**
- **Isn’t it true that we have known since the 1930s that to produce credible data, the measurement process must be controlled?**
- **Isn’t it true that you did not control the measurement process and therefore you cannot document that your data is credible?**

QUALITY CONTROL

- Includes QUANTITATIVE Performance Checks to See if Quality Assurance Has Been Successful
- If QC Measurement Quality Objectives Are Achieved, Data is Accepted

NEEDED FOR ANY MEASUREMENT

- QC is not just for Chemists!
- Physical Measurements or Estimates (% cover, width, % embeddedness)
- Biological or Ecological Measurements or Estimates
- Credible Data Requires that the Measurement or Estimation Process be Controlled.

No Measurement Is Perfect

- Each is an estimate.
- In a controlled measurement, there are quantitative boundaries on how imperfect the result can be.
- These boundaries don't have to be tight.
- Could be ± 40%. But if there are no boundaries, you cannot document it is not ± 2000%

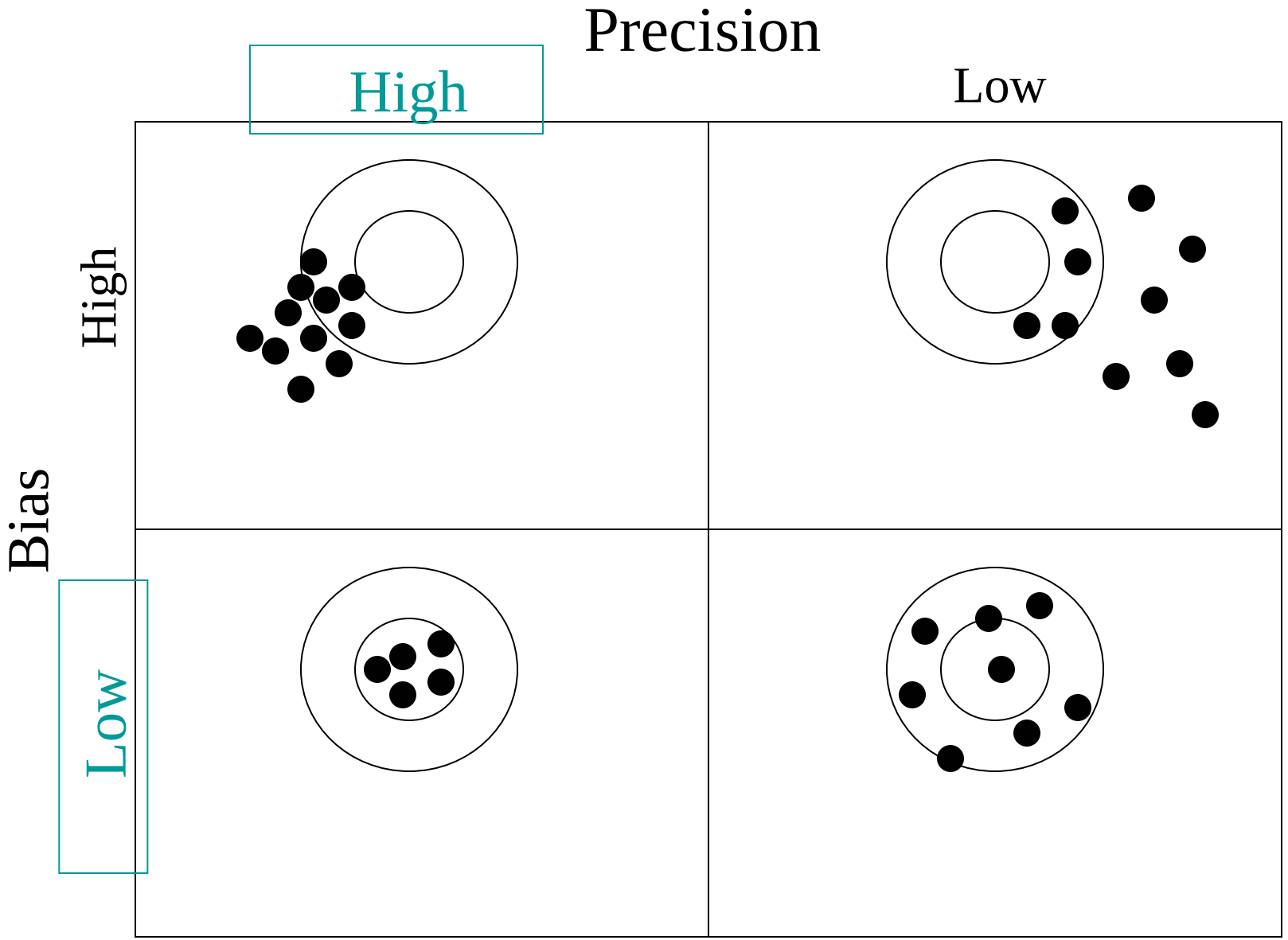
KEY QC MEASUREMENT DATA QUALITY INDICATORS

- Precision
- Systematic Error/Bias
- Sensitivity/Detection Limits
- The Heart of Measurement QC

MEASUREMENT PRECISION UNCERTAINTY

- ON EACH SINGLE DATA POINT
- Was the pH 7.0 or 7.0 plus or minus 0.2?
- NIST, ISO, And Standard Methods Book Agree On Simple Algebra Equation
- U = S x t

Precision and Systematic Error/Bias



Precision, Bias, & Accuracy

- Precision = Measure the Same Thing Repeatedly
- Systematic Error (Bias) = Measure Something When the Right or Expected Answer (100%) is Known, Report the Answer as Recovery (80%, 95%, 140%)
- Uncertainty in Accuracy is a Combination of Uncertainty from Precision and Bias

New: More Precise Terminology for Precision

- Repeatability: Nothing Changes
- Reproducibility: Something Changes, the person, the meter, the lab, etc.
- Field Duplicates, Different But Nearby Samples is Precision as “Reproducibility Plus”
- “Plus” Variability from True Heterogeneity

LOW LEVEL DETECTION LIMITS

- Two Kinds: Semi Quantitative (MDL= 5)
- Quantitative PQL = MDL x 5 = 25)
- Quantitative Measurement Range 25-500
- Only Do Stats on this Range
- Between 5 and 25 “a semi-quantitative estimate” (present greater than zero)
- But 10 is not half of 20
- Censor to PQL for Standards Comparisons

Sensitivity (Detection Limits)

- Based on Repeatability Precision
- Seven Replicate Measures of one Blank
- 99% Confidence Greater than Zero
- The EPA/APHA Method Detection Limit
- The most common semi-qualitative lower detection limit.
- Very Closely Related to Measurement Precision Uncertainty

Simple Equation for MDL

- Method Detection Limit = Sample Standard Deviation x 3.143 (left t value for sample size 7).
- Precision Uncertainty = Sample Standard Deviation x 3.708 (middle t value for sample size 7).
- Assuming Sample Size is 7 and confidence level is 99%.

MEASUREMENT PRECISION UNCERTAINTY

- ON EACH SINGLE DATA POINT
- The pH was not 7.0 exactly
- It was 7.0 plus or minus 0.2

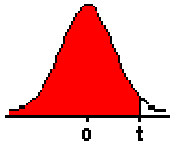
HOW DID WE GET 0.2?

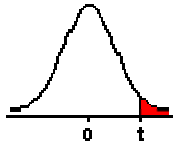
- Exact Same Simple Algebra Equation
- As the Method Detection Limit Equation
- Only Difference:
- Precision uses Left t value
- MDL uses Middle t value
- Get t values from Tables on Internet Calculators for different sample sizes

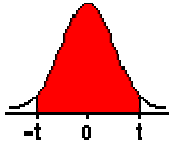
Internet Calculator for t Values

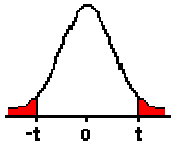
- **University of Cincinnati Surfstat calculator at**
- **http://math.uc.edu/statistics/surfstat/tables.html#t**
- Just Input 0.99 for Probability and
- N-1 for d.f. for MDLs, & Left t Value
- Choose Middle t Value for Precision

t-Distribution









Left tail

Right tail

Middle

Two-tail

d.f.	t value	probability

Understanding Accuracy:

- **Just Bias? No, Misconception of Many**
- **Precision Plus Bias? YES, At Minimum**
- **But how to Quantify?**
- **As Random Error: No, that is Precision**
- **As Uncertainty? Yes!**
- **NIST: Don’t Just Say Accuracy**
- **Instead use “Uncertainty in Accuracy”**

Qualitative QC

Updated Narrative Explanations:

- Data Representativeness
- Data Comparability

Representativeness

- What Larger Universe of Values (The Target Population) is the Sample Representative Of?
- Usually Requires Some Aspect of Randomization
- If nothing else, randomize exactly where you sample at a fixed site, like the second low gradient riffle upstream of a bridge.

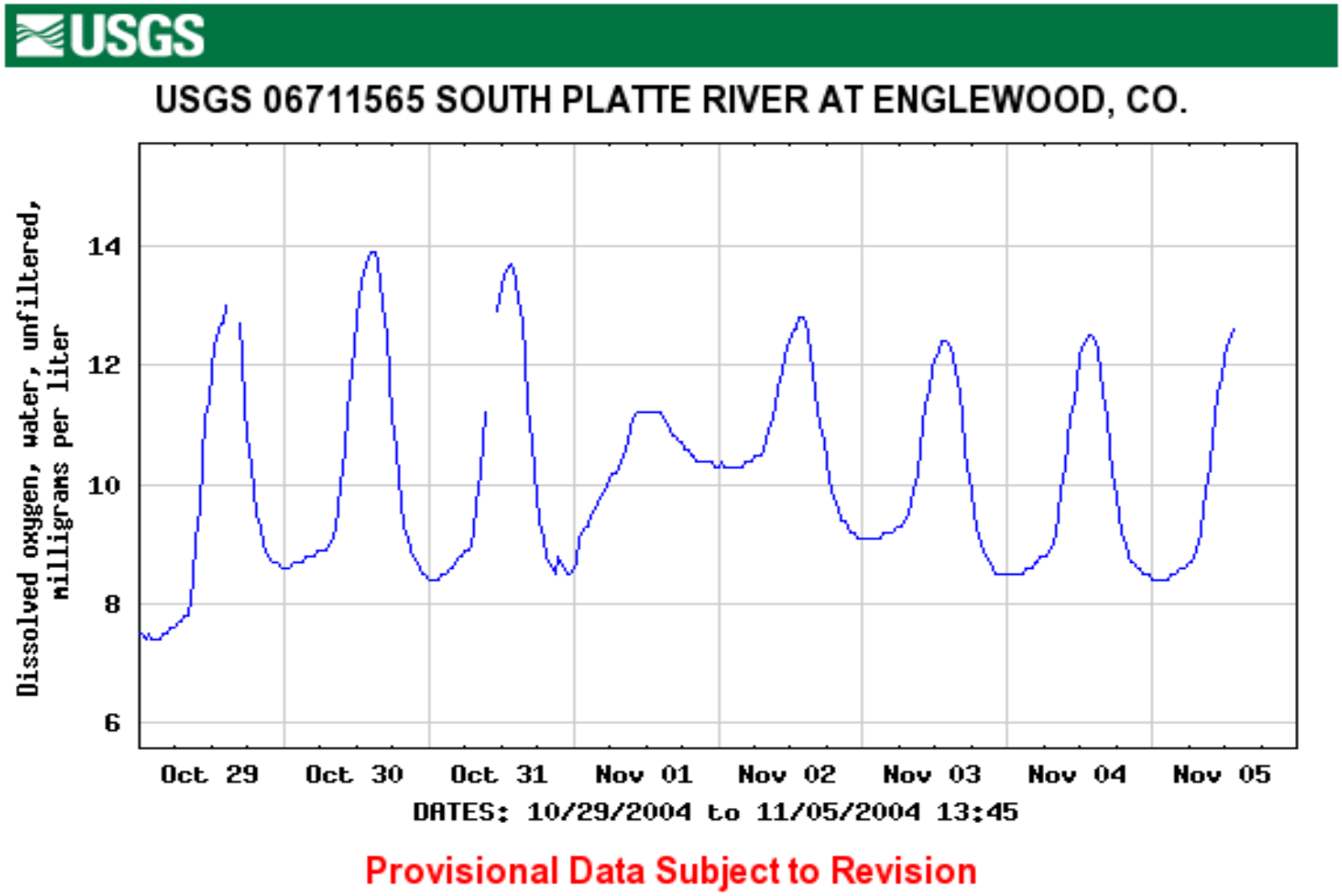
Data Comparability:

1. **Internal: Temporal and methodological consistency in NPS data. Limit method changes and timing changes.**
2. **External: Achieving comparability with other regional data sets (USGS, States, or CERCLA.**

With Diurnal Data

- To Achieve Comparability Within Your Own Data
- You CAN'T Sample In The Morning For 10 Years
- Then Switch To Afternoon Sampling

Dissolved Oxygen Diel Well Known



More Details in Part b

- **Guidance for Vital Signs Monitoring**
- **Being updated at the Website**
- **http://science.nature.nps.gov/im/monitor/protocols/wqPartB.doc**
- **Applicable to Any Measurement Process**

THE BOTTOM LINE

- “Doing Nothing” Is Not an Option, Even if Your Only Goal is to Correctly Understand and Interpret Your Data
- “Do Something” Reasonable on VS Checklist Item Basics: Completeness
- Representativeness & Comparability
- Quantitative Measurement Control of
- Sensitivity, Precision & Bias